CLAIMS

WE CLAIM:

1. A composition comprising a water-soluble fluorescent label comprising an encapsulated noble metal nanocluster.

2. The composition of Claim 1, wherein the noble metal nanocluster comprises between 2 and 8 noble metal atoms.

3. The composition of Claim 1, wherein the noble metal is gold.

4. The composition of Claim 1, wherein the noble metal is silver.

5. The composition of Claim 1, wherein the noble metal is copper.

6. The composition of Claim 1, wherein the encapsulated noble metal nanocluster has a fluorescence quantum yield of greater than approximately 1% and has a saturation intensity ranging from approximately 1 to 1000 W/cm^2

7. The composition of Claim 6, wherein the low excitation intensity is approximately 30 W/cm^2 at approximately 460 nm.

8. The composition of Claim 1, wherein the fluorescent label exhibits a polarized spectral emission and exhibits a dipole emission pattern.

9. The composition of Claim 1, wherein the fluorescent label has a spectral emission that provides information about a biological state.

10. The composition of Claim 9, wherein the biological state is selected from the group consisting of a quantitative and qualitative presence of a biological moiety; structure, composition, and conformation of a biological moiety; localization of a biological moiety in an environment; an interaction between biological moieties, an alteration in structure of a biological compound, and an alteration in a cellular process.

11. The composition of Claim 1, wherein the noble metal nanocluster has a varying charge.

12. The composition of Claim 1, wherein when the fluorescent label is excited, it fluoresces over a pH range of approximately 3 to approximately 8.

13. The composition of Claim 1, wherein the size of the fluorescent label is from approximately less than 1 nm to 15 nm in diameter.

14. The composition of Claim 1, wherein the noble metal nanocluster emits greater than approximately 10^8 photons before photobleaching.

15. The composition of Claim 1, wherein when the composition comprising more than one noble metal nanocluster is excited, greater than approximately 80% of the noble metal nanoclusters fluoresce for greater than approximately 30 minutes.

16. The composition of Claim 15, wherein the noble metal nanoclusters fluoresce at a continuous excitation energy of approximately 300 W/cm^2 at 514.5 nm or 476 nm, and wherein the fluorescence is a saturated fluorescence.

17. The composition of Claim 1, wherein the noble metal nanocluster is encapsulated in a dendrimer.

18. The composition of Claim 17, wherein the dendrimer comprises poly(amidoamine).

19. The composition of Claim 18, wherein the poly(amidoamine) dendrimer is selected from the group consisting of a 0th generation, 1st generation, 2nd generation, 3rd generation, a 4th generation, and a higher generation poly(amidoamine) dendrimer.

20. The composition of Claim 18, wherein the poly(amidoamine) dendrimer is a 2nd generation, or a 4th generation OH-terminated poly(amidoamine) dendrimer.

21. The composition of Claim 1, wherein the noble metal nanocluster is encapsulated in a peptide.

22. The composition of Claim 21, wherein the peptide is from approximately 5-500 amino acids in length.

23. The composition of Claim 21, wherein the peptide is from approximately 5-20 amino acids in length.

24. The composition of Claim 21, wherein the peptide comprises a polypeptide sequence as defined in SEQ ID NO:1.

25. A method of preparing a dendrimer encapsulated noble metal nanocluster, comprising the steps of:
    a) combining a dendrimer, an aqueous solution comprising a noble metal, and an aqueous solvent to create a combined solution;
    b) adding a reducing agent;
    c) subsequently adding a sufficient amount of an acidic compound to adjust the combined solution to a neutral range pH; and
    d) mixing the pH adjusted, combined solution to allow the formation of a dendrimer encapsulated noble metal nanocluster.

26. The method of Claim 25, wherein the reducing agent is selected from the group consisting of light, a chemical reducing agent, and a combination thereof.

27. The method of Claim 25, wherein the temperature of the combined solution is between approximately 65°F to approximately 100°F from step a) through step c).

28. The method of Claim 27, wherein the temperature of the combined solution is between approximately 68°F to approximately 74°F

29. The method of Claim 25, wherein the noble metal is selected from the group consisting of silver, gold, and copper.

30. The method of Claim 25, wherein the aqueous solution comprising a noble metal is selected from the group consisting of $AgNO_3$, $HAuCl_4 \cdot nH_2O$, and $CuSO_4 \cdot nH_2O$.

31. The method of Claim 25, wherein the aqueous solution comprising a noble metal is $HAuCl_4 \cdot nH_2O$, and wherein the pH adjusted, combined solution is mixed for at least one hour to allow the formation of the dendrimer encapsulated gold nanocluster.

32. The method of Claim 31, wherein the pH adjusted, combined solution is mixed for about 48 hours to allow the formation of a dendrimer encapsulated gold nanocluster.

33. The method of Claim 25, wherein the dendrimer encapsulated noble metal nanocluster exhibits a polarized spectral emission when excited at a low excitation intensity of approximately 30 W/cm^2 at approximately 460 nm.

34. The method of Claim 25, wherein when the dendrimer encapsulated noble metal nanocluster is excited, has a spectral emission at least partially determined by the size of the nanocluster.

35. The method of Claim 25, wherein the dendrimer encapsulated noble metal nanocluster is capable of fluorescing over a pH range of approximately 3 to 8.

36. The method of Claim 25, wherein the dendrimer encapsulated noble metal nanocluster emits greater than approximately 10^6 photons before photobleaching.

37. The method of Claim 25, wherein when more than one encapsulated noble metal nanocluster is excited, greater than approximately 90% of the noble metal nanoclusters fluoresce for greater than approximately 30 minutes at a continuous excitation energy of approximately 300 W/cm^2 at 514.5 nm or 476 nm.

38. The method of Claim 25, wherein the dendrimer comprises poly(amidoamine).

39. The method of Claim 38, wherein the poly(amidoamine) dendrimer is selected from the group consisting of a 0^{th} generation, 1^{st} generation, 2^{nd} generation, 3^{rd} generation, a 4^{th} generation, and a higher generation poly(amidoamine) dendrimer.

40. A method of preparing a peptide encapsulated noble metal nanocluster capable of fluorescing, comprising the steps of:
    a) combining a peptide, an aqueous solution comprising a noble metal, and distilled water to create a combined solution;
    b) adding a reducing agent;
    c) subsequently adding a sufficient amount of an acidic compound to adjust the combined solution to a neutral range pH; and
    d) mixing the pH adjusted, combined solution to allow the formation of the peptide encapsulated noble metal nanocluster.

41. The method of Claim 40, wherein the reducing agent is selected from the group consisting of light, a chemical reducing agent, and a combination thereof.

42. The method of Claim 40, wherein the noble metal to peptide molar ratio in step a) is approximately 0.1:1.

43. The method of Claim 40, wherein the temperature of the combined solution is between approximately 65°F to approximately 100 °F from step a) through step c).

44. The method of Claim 43, wherein the temperature of the combined solution is between approximately 68 °F to approximately 74 °F.

45. The method of Claim 40, wherein the noble metal is selected from the group consisting of silver, gold, and copper.

46. The method of Claim 40, wherein the aqueous solution comprising a noble metal is selected from the group consisting of $AgNO_3$, $HAuCl_4 \cdot nH_2O$, and $CuSO_4 \cdot nH_2O$.

47. The method of Claim 40, wherein the peptide is from approximately 5-500 amino acids in length

48. The method of Claim 40, wherein the peptide is from approximately 5-20 amino acids in length.

49. The method of Claim 40, wherein the peptide comprises a polypeptide sequence as defined in SEQ ID NO:1.

50. The method of Claim 40, wherein the size of the peptide encapsulated noble metal nanoclusters is from approximately less than 1 nm to approximately 15 nm in diameter.

51. The method of Claim 40, wherein the peptide encapsulated noble metal nanocluster is capable of fluorescing over a pH range of approximately 3 to 9.

52. The method of Claim 40, wherein the peptide encapsulated noble metal nanocluster emits greater than approximately 10^6 photons before photobleaching.

53. The method of Claim 40, wherein when more than one peptide encapsulated noble metal nanoclusters is excited, greater than approximately 90% of the noble metal nanoclusters fluoresce for greater than approximately 30 minutes at a continuous excitation energy of approximately 300 W/cm^2 at 514.5 nm or 476 nm.

54. A method of monitoring a molecule of interest comprising:
    a) attaching a water-soluble fluorescent label comprising an encapsulated noble metal nanocluster to a molecule of interest, wherein the fluorescent label emits an emission spectrum; and
    b) detecting the emission spectrum of the fluorescent label.

55. The method of Claim 54, wherein the noble metal nanocluster comprises between 2 and 8 noble metal atoms.

56. The method of Claim 54, wherein the noble metal is selected from the group consisting of gold, silver, and copper.

57. The method of Claim 54, wherein the encapsulated noble metal nanocluster fluoresces at a low excitation intensity and wherein the encapsulated noble metal nanocluster has a saturation intensity ranging from approximately 1 to 1000 W/cm^2 at a nanocluster excitation maximum.

58. The method of Claim 57, wherein the low excitation intensity is approximately 30 W/cm^2 at approximately 460 nm.

59. The method of Claim 54, wherein the fluorescent label exhibits a polarized spectral emission and exhibits a dipole emission pattern.

60. The method of Claim 54, wherein the fluorescent label has a spectral emission that provides information about a biological state.

61. The method of Claim 60, wherein the biological state is selected from the group consisting of a quantitative and qualitative presence of a biological moiety; structure, composition, and conformation of a biological moiety; localization of a biological moiety in an environment; an interaction between biological moieties, an alteration in structure of a biological compound, and an alteration in a cellular process.

62. The method of Claim 54, wherein when the fluorescent label is excited, it is capable of fluorescing over a pH range of approximately 3 to 9.

63. The method of Claim 54, wherein the noble metal nanocluster emits greater than approximately 10^6 photons before photobleaching.

64. The method of Claim 54, wherein when a composition comprising more than one noble metal nanocluster is excited, greater than approximately 80% of the noble metal nanoclusters fluoresce for greater than approximately 30 minutes.

65. The method of Claim 64, wherein the noble metal nanoclusters fluoresce at a continuous excitation energy of approximately 300 W/cm^2 at 514.5 nm or 476 nm, and wherein the fluorescence is a saturated or an unsaturated fluorescence.

66. The method of Claim 54, further comprising the initial step of attaching a linker molecule to the encapsulated noble metal nanocluster, wherein the linker molecule is capable of attaching the fluorescent label to the molecule of interest.

67. The method of Claim 54, wherein the molecule of interest is present in a biological sample.

68. The method of Claim 54, wherein the size of the fluorescent label is from approximately less than 1 nm to 15 nm in diameter.

69. The method of Claim 54, wherein the noble metal nanocluster is encapsulated in a dendrimer.

70. The method of Claim 69, wherein the dendrimer comprises poly(amidoamine).

71. The method of Claim 70, wherein the poly(amidoamine) dendrimer is selected from the group consisting of a 0th generation, 1st generation, 2nd generation, 3rd generation, a 4th generation, and a higher generation poly(amidoamine) dendrimer.

72. The method of Claim 70, wherein the poly(amidoamine) dendrimer is a 2nd generation, or a 4th generation OH-terminated poly(amidoamine) dendrimer.

73. The method of Claim 54, wherein the noble metal nanocluster is encapsulated in a peptide.

74. The method of Claim 73, wherein the peptide is expressed in a cell.

75. The method of Claim 73, wherein the peptide comprises a fusion polypeptide.

76. The method of Claim 73, wherein the peptide is from approximately 5-500 amino acids in length.

77. The method of Claim 73, wherein the peptide is from approximately 5-20 amino acids in length.

78. The method of Claim 73, wherein the peptide is from approximately 20-40 amino acids in length.

79. The method of Claim 73, wherein the peptide comprises a polypeptide sequence as defined in SEQ ID NO:1.